

REMARKS

The Office Action dated February 3, 2003, has been reviewed carefully and the Applicants have the following remarks.

Claim Rejections - 35 U.S.C. § 102

Claims 6, 7, 11 and 12 were rejected under 35 U.S.C. § 102(e) as being anticipated by Bahar et al., U.S. Patent RE 37656 E ("Bahar").

Briefly, Applicants' invention is a layered membrane and membrane electrode assembly that supports a high level of total protonic exchange in a direct oxidation fuel cell, yet significantly reduces carryover of water and fuel crossover. In other words, one of the objectives of Applicants' invention is to manage water and fuel so that there is less water recirculation necessary and less crossover of fuel from the anode to the cathode side without reacting on the membrane. The invention employs a barrier material that is substantially impermeable to water and fuel. This barrier material is the substrate in a sandwich type configuration. A layer of protonically-conductive material is placed on each opposing aspect of the barrier material such that the barrier material is sandwiched between the two layers of protonically-conductive material to form a layered membrane. In the membrane electrode assembly, the layered membrane is, in turn, sandwiched between two layers of catalyst and layers of diffusion material are then disposed on the surfaces of the catalyst layers. The barrier layer is preferably constructed of a material that is substantially impermeable to water and fuel but which

allows protons to pass from the anode to the cathode. The barrier layer is microporous and the pores in the barrier layer allow protonically-conducting contact between the protonically-conductive membrane layers, i.e. PCMs 36a-36b (Fig. 3).

Even though this assembly can result in introducing a modest increase in the reaction resistance of the fuel cell, the substantial prevention of carryover of fuel and water still enables a direct oxidation fuel cell to operate with a higher fuel concentration, which results in a highly efficient direct oxidation fuel cell.

Bahar, on the other hand, describes a composite membrane, which includes a base material that is a set of nodes interconnected by fibrils or porous microstructure characterized substantially by fibrils, such as expanded PTFE. Thus, Bahar discloses a PTFE mesh upon which NAFION® (a protonically-conductive material) is painted onto the mesh to fill in the holes, thus creating a membrane that is substantially impermeable to air and that does not allow for fluid percolation (col. 3, lines 1-3). The construction of the Bahar membrane is different than that claimed by the Applicants. In addition, the teaching of the Bahar reference is that a fuel cell utilizing the Bahar membrane operates at a higher voltage for a given current density due to improved ionic conductance of thinner versions of the membrane. This teaches away from Applicants' invention because Applicants' membrane has a loss in conductance, which is a trade-off for the improved operation that results from a fuel cell that has less methanol crossover.

With respect to claim 6, claim 6 is not anticipated by the Bahar reference because claim 6 recites a first and second protonically-conductive membrane disposed on

opposite aspects of the barrier layer. In addition, selected sites in the barrier layer enable protonically-conductive contact between the first and second membranes. This is illustrated in Applicants' Fig. 4, for example. The Bahar reference does not suggest a sandwich configuration in which protonically-conductive material (PCMs 36a and 36b) are placed over an internal barrier layer. Bahar, on the other hand, discloses a membrane, which is a base material that is a mesh. It is painted or coated with an ionic exchange material or ionic exchange resin, which fills the openings in the base material 4. A non-woven material 6 can be bonded on one side of the base material for reinforcement (Fig. 2, Bahar). Thus, Bahar's construction results in uniform protonic conductivity whereas Applicants' disclose "selected sites" of protonic conductivity. Accordingly, the invention of claim 6 is not anticipated by Bahar.

Claim 7 requires the further limitation that the barrier layer comprises a microporous material. This is still not anticipated by Bahar because the barrier layer is sandwiched between two protonically-conductive membranes. Similarly, claim 11 recites a method of constructing a layered membrane that requires an impermeable layer that has, provided on opposite sides, protonically-conductive membranes on each side and sites in the layer that allow protonically-conductive contact. Claim 12 adds the further limitation that the layer may be a microporous material. Once again, this is not anticipated by Bahar, which is simply an expanded PTFE mesh that has been painted with a NAFION® type substance.

Claim Rejections - 35 U.S.C. § 103

Claims 1, 2, 5, 10, 15, 16, 19, 20 and 23 were rejected under 35 U.S.C. § 103(a) over Bahar.

Claims 1, 2 and 5 related to a membrane electrode assembly, which includes the barrier layer, just discussed, and protonically-conductive membranes disposed respectively on opposite sides of the layer with selected sites enabling protonically-conductive contact. First and second catalysts are disposed respectively on the surfaces of the membrane as well as first and second diffusion materials. Claims 5 and 10 relate to the use of such a membrane within a direct methanol fuel cell, as noted by the Examiner. Bahar does not disclose using a membrane in a direct oxidation fuel cell or the use of catalytic and diffusion layers for such fuel cell. Bahar also does not disclose a layered membrane, which is a sandwich-type configuration in which the middle layer is not the ionic exchange membrane, but instead is a barrier layer to control water and methanol crossover and water management generally within the fuel cell. Bahar teaches away from Applicants' invention, and cannot have rendered Applicants' invention obvious, because, in fact, as noted by the Examiner, Bahar teaches improving conductance by enhancing water transport across the membrane. Bahar is not teaching solutions to the problem of methanol crossing over the membrane and not participating in the electricity-generating reactions of the fuel cell, thus wasting fuel. Thus, Applicants' invention as a whole is not obvious to one skilled in the art based on the teachings of Bahar.

Allowable Subject Matter

Claims 3, 4, 8, 9, 13, 14, 17, 18, 21 and 22 were indicated as allowable. Applicants will rewrite those claims in independent form after the Examiner has had an opportunity to consider the arguments presented herein.

Prior Art References

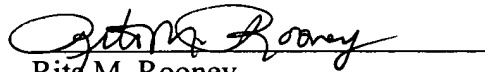
Applicants have noted that the Examiner has made notes on a copy of the Form-PTO-1449, that is date stamped as received in the Technology Center 1700 on October 24, 2002, which Applicants filed in connection with an Information Disclosure Statement. Applicants are providing herewith a Supplemental Form-PTO-1449 in which as much information as is readily available about the dates of these documents is provided, and we are determining the other information and will supply it as soon as it becomes available.

The Examiner initialed the Form-PTO-1449 and this indicates to the Applicants that the Examiner has considered those references, however, if the Examiner has not considered all of the references cited on Applicants' Form-PTO-1449 (which is date stamped with the TC 1700 date stamp of October 24, 2002), the Applicants respectfully requests that the Examiner notify Applicants of this matter.

Please do not hesitate to contact the undersigned in order to advance the prosecution of this application in any respect.

Please charge any additional fee occasioned by this paper to our Deposit Account No. 03-1237.

Respectfully submitted,

A handwritten signature in cursive script, appearing to read "Rita M. Rooney", is written over a horizontal line.

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